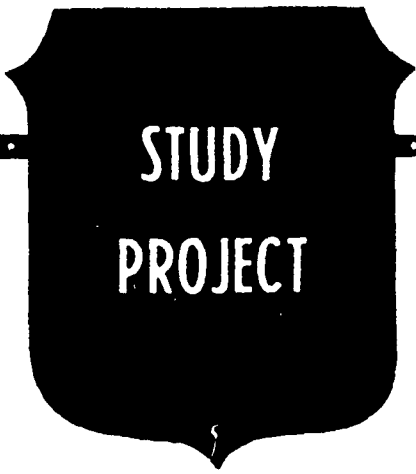


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THE PERSONAL COMPUTER
AN UNTAPPED SOURCE FOR THE
UNITED STATES ARMY WAR COLLEGE

BY

LIEUTENANT COLONEL CHARLES E. PERSYN

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USAWC MILITARY STUDIES PROGRAM

THE PERSONAL COMPUTER
AN UNTAPPED RESOURCE FOR THE
UNITED STATES ARMY WAR COLLEGE

BY:

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United States Army War College
Carlisle Barracks, Pennsylvania 17013

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ABSTRACT

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This essay examines the dramatic changes made in the use of personal computers in civilian universities, and explores the concept of educational computing. The author presents the idea of an educational computing model and its application in the USAWC. Department of Defense Policy, and Army Information Management Regulations are discussed where applicable. Finally, the author presents some recommendations based on: known fiscal constraints, an analysis of the present computer system at the USAWC, and on lessons learned in business and civilian universities.

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A New Computing Model For The Army War College

The United States Army War College's charter involves, as do all institutions of higher learning, the creation, dissemination, and analysis of information. As an academic institution, the embracing of new technologies that improve learning is important to its purpose and mission accomplishment.

Today the personal computer (PC) is playing a more vital role in higher education. It is the instrument used to teach the modern technologies in assembling information, computing, and communication. The PCs have shaped the notion of computers as individual tools, rather than some scarce commodity used only by "eggheads" or "number crunchers" on a time-shared basis. They have expanded into new applications, such as electronic spreadsheets and individual databases, and automated such activities as typing, drawing, and graphics. Equally important, they have spurred significant shifts in the way universities designed their electronic infrastructures.

It is obvious that the traditional uses of the personal computer are deeply rooted into the work-place and in academics, but the machine's fundamental impact on computing is taking on new dimensions. The new advanced function technology heralds a new computing and communications concept for higher education and the work-place. This new concept retains the "personal" aspect of the title "personal computer" and replaces the "computing" aspect with

information access and management. Information Access and Management is becoming one of the most important aspects of success or failure in almost any venture in today's world. Information Access and Management is the ability to support meaningful collaboration among colleagues regardless of location, the instantaneous access to the world's knowledge, the new levels of graphic capabilities that elevate the presentation of information to the same level as its content, and the multitasking capability that allows people to do more than one thing at a time.

In his article "American Strategy from its beginning through the First World War," Russell Weigley wrote the following passage which suggests the basic purpose of the Army War College:

"The Army does need to have some genuinely intellectual elements in its leadership. When we move beyond tactics to the operational, strategic and organizational levels of the military activity, we begin to require deep intellect above leadership charisma. High command requires an intellectual component entirely separate from that required to lead troops in combat." 1

Thanks to the Information Access and Management power of personal computers, military leaders are working more like intellects and classic researchers, gathering and integrating information from multiple sources and assimilating it for presentation and persuasion. For the most part, these computer skills are self taught. The military institutions of learning, not unlike their civilian counterparts, have failed to keep up with technology and to incorporate computer literacy (not programming and system

architecture, but the power of Information Access and Management) and research training into their curriculums.

The curriculum of U.S. military schools leading up to the Army War College, in my considered opinion, is largely defined in the context of a World War II era mentality. That is, military leaders learned to deal with finite situations, and formulate solutions using memorized sets of rules. Today, the real skills that military leaders need are those that enable them to deal with abstract ideas, to be able to take information, evaluate it, put it into context and draw conclusions. Thinking skills need to be emphasized, not memorization skills. The Army War College is the only institution in my career development where the teaching of thinking skills emerged and formed the basis of the curriculum.

To further build on this concept, the Army War College must recognize the potential power of personal computers and rethink its electronic infrastructure. The heart of the structure should be built around a computer network that will allow students and instructors to communicate with each other, with data bases and other on-line resources.

Ideally, students and instructors should learn to depend upon the benefits of shared computing resources. As part of an ideal computing model, every student quarters and classroom desk, instructor office and home desk, research station, and library desk should have a point of entry to

the college network, which in turn connects to the global military planning and academic community.

This concept is starting to emerge at colleges and universities throughout the United States. Personal computers are becoming an integral part of the curriculum. The use of the PC is moving beyond simply writing term papers. MBA candidates work up their case studies on IBM PCs or compatibles running LOTUS 1-2-3, and design presentations using the graphically oriented Apple Macintosh. By increasing the number and availability of machines to the students and teachers emphasizing their use. The PCs get pressed into use for everything from running on-line, intra-campus bulletin boards to creating banners and flyers for campus-wide functions.

Such institutions are also leading the way in networking, with many schools connecting all the dorms and offices: Students at Georgia Tech can browse the library's card catalog from their dorm rooms, while computer users at Stevens Tech, Hoboken, NJ, will soon have access to the power of supercomputers (next generation technology providing greatly enhanced processing speed) for sophisticated calculations. Quite a few colleges and universities recommend that students buy their own machines; these schools often orchestrate volume purchases in order to lower the cost of computers. A handful of schools have gone beyond saying that owning a computer is a good idea. Universities such as the United States Military Academy,

Stevens Tech, Drexel University in Philadelphia, PA, and Clarkson University in Potsdam, NY, made personal computer ownership mandatory for all incoming first-year students. The ultimate goal is to provide students with the requisite computer skills to gain entry to, and then succeed in, the business world. 2

The PC has proven so useful in higher education that most schools now provide "computer cluster rooms" (workrooms). Much like the Executive Skills Center at the Army War College, but with software tools that facilitate study and research, and augment the classroom instruction. Even though the Army War College has made some inroads in addressing and harnessing the immense potential of personal computers in the learning process, the reality is that PCs have not made the sweeping changes in the education process that they have in the work-place. At the Pentagon, for example, most project officers have an IBM/Compatible or a Macintosh on their desk. Yet what PCs offer for the Army War College remains tantalizingly out of reach. If the college could get the computer power and financial resources necessary, seminar rooms might, for example, become environments for discovery through interactive, multimedia programs. This then leads to "networking" which presents the most intriguing potential for the seminar learning concept. When doing research, students might be able to link with other students and instructors at other institutions like the Naval and Air Force War Colleges, or

the different service schools and military senior leaders, thus broadening understanding and appreciation of other ideas and the other services.

The power of telecommunications and networking is not a new vision, and it is not that the vision of the PC's potential has been faulty. Rather, we have badly underestimated the complexities of weaving new technologies into the fabric of the educational system at the Army War College. PCs were purchased, installed, and tied together without seriously considering the changes needed in the teaching techniques. Instructors and curriculum designers have gone about their business in a manner that has been remarkably unchanged for generations. The traditional teaching techniques of the Army War College were conceived by Secretary of War Elihu Root in 1901. The marriage of innovation and technology with strong tradition has truly been on a rocky road.

This study project will look at the dramatic changes made by civilian universities in the use of personal computers, and explore their lessons learned. Next is a critical (constructive) look at where the Army War College is in educational computing with some recommendations on where it should go from there. Army regulatory guidance will be inserted where applicable. The purpose is to provide a "think piece" to aid the leadership at the college in matching resources with educational and management computer needs.

Educational Computing

Since the mid 1980's the use of personal computers in civilian universities has changed dramatically. Educational software development and networking systems have flourished. The schools mentioned earlier in this study are some of those that have paved the way for other institutions. Many schools have made significant progress in the application and use of PCs in education. They only differ in size and academic focus, but all share a commitment to the idea that putting powerful tools in the hands of students and faculty can make a big difference in quality education. Here is a brief description of what is going on at Stanford University, Palo Alto, California, and Carnegie Mellon University, Pittsburg, Pennsylvania. I consider them typical. They offer good models for the Army War College. Useful lessons learned can be drawn from their experiences.

As PCs began to proliferate on the Stanford campus, it became clear that no single standard could be imposed on the diverse population of a major university. Rather than trying to force faculty, students, and staff to adopt a particular computer, Stanford has relied on a sort of guided evolution -- "encouraging flexible but focused growth." The simple strategy seemed to work well, producing an impressive body of faculty-developed software. PCs are available to the Stanford community in large numbers, and an increasing number of faculty are taking advantage of them in presenting information to their students.

Stanford has computer clusters in libraries for student course work and word processing. Each cluster has a mix of Macintoshes and IBM PCs. Each cluster offers terminals connected to the timesharing system, through the university Local Area Network (LAN). Stanford also has "interactive classrooms;" a network of Macintosh Plus computers, with an image-switching system to allow instructor previewing and common user viewing of Macintosh display screens. Also available to students and faculty are IBM PCs with video disk capabilities, access to the LAN, and local area file service. Anyone who wants his or her own PC at Stanford can rent one from the Workstation Support Center or buy one at a considerable discount through the bookstore. 3

The Information and Technology Center at Carnegie is charged with designing and developing the workstation environment and the communications system. The model used at the United States Military Academy and Carnegie is a marriage between personal computers and time-sharing on main frame minicomputers. It incorporates the flexibility made possible by the PCs with the information sharing characteristics of the time-sharing. Carnegie, for example, accomplished this with the use of a campus wide communications system (Local Area Network) designed to expand gracefully to a network capable of several thousand VIRTUE work stations. The system is similar to the one installed at the Army War College in using the UNIX operating system.

A VIRTUE work station is a powerful tool -- an IBM PC, Sun, or MicroVAX with a couple of megabytes of memory, a 1000-by 800-pixel screen, and processing speed of 20 MHz. VIRTUE software includes a window manager with subroutine libraries for text, graphics, and data manipulation; a data base subroutine manager, and applications for electronic mail and bulletin boards. Electronic bulletin boards seem to be a natural outgrowth of a campus wide network. In fact, the Carnegie network has about 300 bulletin boards.

Carnegie recognized the need for instructors to develop software in their fields of study. Building on their experience with PLATO, short for Programmed Logic for Automated Teaching Operation, Carnegie developed a software creating environment. (PLATO resources are distributed to educational services throughout TRADOC). An environment by which teachers can create interactive courseware (a word derived from the word software) with sophisticated graphics. This environment, called CMU (Carnegie-Mellon University) Tutor, makes it easy for an instructor with little prior programming experience to exploit the power of the PCs. CMU Tutor programs have been designed for IBM PCs and for Macintosh as well. In a series of one-week workshops at Carnegie, teachers from around the country learned to use CMU Tutor and many in the one week developed "significant," graphics-oriented courseware packages. 4

Another burgeoning educational computing technique is the one exploited by TeleLearning Systems of San Francisco. The firm operates the Electronic University Network (EUN), a teaching technique that would nicely fit the needs of the Army War College non-resident courses. During its four-year history TeleLearning Systems has delivered college-level courses electronically, using telecommunications as the link between instructor and student. The "Protege" software is the heart of EUN's system. It is completely menu-driven and operates on one-key commands. All assignments are completed using the Protege disk. On disk are knowledge templates for performing all course requirements. For example, if the student wants to send the instructor a question or pose a problem, the student simply composes it in the electronic mail template. To send the note to the instructor, the student turns-on his modem, hits one key, and his message is automatically delivered.

Currently, 200 colleges and universities participate in the program that forms EUN and provide EUN with more than 200 on line courses. Each university or college develops its own course for inclusion in the EUN course catalog. Credit is granted from the institution that developed the course. EUN is simply the link between the student and the instructor. On the college transcript there is no difference between a class taken on campus or over the modem. 5

The above examples provide direction and techniques for the development of the Army War College model in several key areas of educational computing. The need for integrating the power of the personal computer into the educational process is obvious. The lessons learned by these and other universities and colleges are in the areas of information access through: campus networking of personal computers; the initiating of faculty training and the development of easy to use programing techniques; the matching of the machine to the needs of the instructor and the student (Macintosh is excellent for courses that emphasize presentation and graphics, and IBM PCs and compatibles are excellent for the data manipulation and file transfer); and, telecommunications play an important role in completing the program of easy access to and transfer of information -- Information Access and Management.

Where is the USAWC in Educational Computing?

The United States Army War College is about par for the course as compared to most civilian universities and other military educational institutions. Personal Computers are provided for easy access to students and faculty; recently a PC cluster room was created next to the library, and PCs or terminals are available in each seminar room. However, several issues need to be dealt with before the true power of personal computers can be achieved:

First, the teaching process hardly reflects the technological advances available. This is a problem faced by businessmen and educators. Technological advances move faster than educators wish to change. Moreover, military leaders are, to a fault, conservative about investing in expensive hardware. Once having bought computers, they expect them to last forever and turn to the cheaper off-the-shelf software for solutions. Off-the-shelf software can provide greatly enhanced capabilities, but there is a time when the machine can no longer drive the software to its fullest benefit. Military contractors write specifications, entertain proposals, and buy all the same machines based on the lowest bidder. Even more damaging is that little money is allocated for instructor training or for a technical staff for courseware (course software) development.

Second, where teachers are inclined to use computers, they often do not know what is available, or are too awed

by technology to make much headway without lots of help. A staff of technically qualified programmers is paramount -- a staff free of routine system maintenance and troubleshooting tasks, and dedicated to programming the needs of the faculty. Reliance on off-the-shelf software can be harmful. Off-the-shelf software does not necessarily meet the needs of the instructor and can dampen student enthusiasm.

Third, computer-based instruction is limited to computer literacy in word processing. There is a need for a whole revamping of the computer curriculum to teach students how to take advantage of what personal computers can offer. The best way to learn the benefits of computers is to learn by doing. Computer literacy is not obtained by taking courses in programming and system architecture; it is meaningful practical application in using the system and the machines that they will most likely use in their next assignments. The Pentagon, most Unified and Specified Commands, and U.S. NATO offices, for example, use Macintosh and IBM/Compatibles. Word Perfect seems to be the most common word processor.

Fourth, there are still not enough computers available to create the needed environment. The INTEL 310 and 320 systems are slow (processor is less than 8 MHZ, reasonable processor speed requires at least 20 MHZ) and are limited to

number crunching and data management, and the Q-ONE word processor is very user unfriendly. Machines that provide ease, to use high quality presentation and graphic packages are not available. (Machines like the Macintosh Plus could be used to augment the number crunching machines).

It could prove to be very expensive to design and build a system to meet all the requirements of the USAWC. The "new educational computing model" discussed earlier is a concept that can help in formulating solutions to the problems described above. It would require a nearly complete overhaul of the existing system to fully implement the model. Funding such a program would be difficult, particularly in these austere times.

Funding for automation has come under very tight controls. A congressional inquiry into the automation practices of DoD revealed what congress considered as mismanagement in automation procurement and management. The FY-90 Appropriations Bill stated that "ADP management is out of control in all of DoD, and in the Army in particular." The bill cut \$238.1 million from the Army ADP OMA (Operations and Maintenance, Army) account, cut \$31.8 million from the ADP OPA (Other Procurement, Army) account, and imposed a ceiling on automation O&M (Operations and Maintenance) accounts. Congress also imposed a rule that forbids commanders from moving funds from outside the ADP

area into ADF accounts -- no reprogramming of funds. These fiscal limitations will restrict what the USAWC can do in updating the LAN and the system hardware.

Fiscal constraints will not make major system design changes (hardware and software) practical at this time. However, the educational computing model and the issues discussed in previous sections should serve as planning guidelines for future automation decisions. As appropriations are realized, the system design should follow an educational computing concept that is based on an idea of expanding to meet the expanding needs of the educational computing environment. Although funds are tight, improvements can be made within current funding and within the present system.

The following are some ideas on what can be done at little or no additional cost. First, the Army War College needs to open its local area network (LAN) to all students, resident and non-resident. The emphasis here is to provide remote access for student system and student instructor interaction, and to exploit the power of the personally owned PCs. Secondly, the school should provide the right mix in capabilities to manipulate data and create presentation formats and graphics. As most universities and businesses have discovered, the best way to do this is by a proper mix of machines rather than revamping the entire system. Let's first consider the machine mix concept, and

then consider what can be done to open the college's network for remote access to the college's LAN and to other networks and systems.

Without the resources for total restructure of the present system, the best option is to integrate a high performance graphics machine in with the different DOS, UNIX, and XENIX operating systems used at Carlisle Barracks. Some education and business system designers argue that the solution is in the new graphics software developed for DOS, UNIX and XENIX machines. But all seem to agree, to varying degrees, that none are as simple to use or as good as the Macintosh package for drawing or graphics. It seems that making other operating systems and the MAC system work together has become a fact of life for business and education. The primary reason seems to be the cost involved in complete overhaul of their systems -- cost outweigh the benefits. Fortunately, compatibility has become a key issue for most hardware and software firms, IBM, Apple and many others in the personal computer and software market. Compatibility comes in many forms and prices, and must be matched to the machines and operating systems presently used.

A recent USAWC survey indicated that of the 342 respondents (71 percent survey return rate), 74 percent of the students and 58 percent of the Staff and Faculty owned personal computers. Twenty one percent of those owned Apple or Macintosh PCs and 57 percent have IBM or IBM compatibles.

Twenty-nine percent of them have modems, and 41 percent of that number have no communication software. The issue then is how to move information between these machines, and do it easily and inexpensively. 6

Moving data between other operating systems and MACs is a problem of physical connectivity as well as file compatibility -- you must find a way first to get files from one machine to another, and then for one machine to read the other's file format. The resulting solutions fall into three main categories, depending on whether the information exchange is between individual machines, among a mix of operating systems and MACs on a LAN, or among computers at various locations around the country. The latter two situations apply to the USAWC -- mix of machines, LAN and remote connectivity and compatibility.

LAN and remote station connectivity and compatibility is feasible and would be relatively inexpensive for the USAWC. The software is available to facilitate the transfer of files over cable connecting serial ports on both machines, or over telephone lines via modems. To achieve this, a communications program must be run on each machine. Software products, like MacLink Plus/PC or LapLink Mac, come with communications software, serial cable to link the two machines, and a file format translator that converts files for each machine. LapLink Mac is designed to be used only

with a serial cable, while MacLink Plus/PC will work over a serial cable, a local area network (LAN), or telephone lines.

How would or could this work at the USAWC? If a DOS user at the college and nonresident MAC user, for example, both have modems, communications software, and access to a common bulletin board or electronic mail systems (the college has both), one user can upload data to the service for the other to download. For infrequent exchanges of small data files, course paper or small data file exchange, an E-mail service or bulletin board system is the most cost effective solution. Commercial MCI or Sprint Mail, for example, cost from 50 cents to a few dollars, equal to or less than postal service and much faster.

For LAN users and modem communications the least expensive technique is an emulation product. Century Software, Salt Lake City, Utah, for example, markets a product called TERM. TERM is a good example of the powerful communications packages available which feature exact terminal emulations, and powerful file transfer protocols. The core purpose of TERM is to provide effective and easy communications be it terminal emulation or file transfer between Unix and Xenix (the two used at the USAWC), or DOS/MSDOS (used at the CBKS IBM 4361 system and most personally owned PCs), as well as VMS, Macintosh, and BTOS systems. The same user interface exists on all systems so that users are not required to re-learn TERM for each

different machine. The TERM software cost is typical for the market: PC version -- \$195, Minicomputer (Sperry 5000 for example) -- \$695. (TERM information and cost estimates were provided by a Century Software area sales representative.) In addition, to file transfer this allows everyone the use of high quality peripherals, such as laser printers.

Using a system emulator is not without its drawbacks. The PC using the emulator software attaches to a host system, such as the USAWC library CATS or the UNISYS 5000 minicomputer, in either of two ways. The PC can emulate a dumb terminal, or the PC can use the host minicomputer as a storage device. In the first case, the PC's power is unused, and every additional work station affects system performance and throughput. The other drawback is that hardware emulation is never total -- some of the functions (power) of the PC is lost as it tries to emulate the host work station. The impact on the communications and host systems can be significant. PCs are much more powerful than a terminal and can move data in large blocks and therefore can overload the host communications system.

There are alternative solutions to the communication dilemma. Before moving to the opening of the USAWC LAN for remote access by personally owned PCs, it is important to explore the alternatives. It is also important to understand the DoD standards for networking.

Exploring the Communication Alternatives

For the person who wants to remotely connect several PCs to an existing LAN, communicate among them, and share peripherals, several alternatives are available. One alternative is to use a PBX (Public Branch exchange) system instead of a coax cable connection to the LAN. Most military installations have their own internal telephone systems with a central control unit known as a PBX. PBXs and their telephone wiring systems can carry data traffic and interconnect attached PCs. If a PBX already is installed and the connectivity requirements are for infrequent file transfers, the PBX may be a practical solution. But a PBX is not a direct alternative to a LAN. The PBX is designed to service a high volume of short communications at low baud rates. Most data network traffic involves lengthy work sessions at high baud rates, which the PBX does not handle well. Also, whereas PBX can handle simple file transfers, they have not been equipped to provide file-handling services such as security, data integrity, and disk management, which are important elements of a data network but would serve the purpose of student infrequent connection and file service.

A more efficient way to use an existing telephone network may be to bypass the PBX and use just the wiring system. LANs work adequately on standard telephone wire, provided that the wire and junctions are in good condition. This technique is a viable option on most installations. It

would require the dedication of an appropriate number of telephone lines. The PBX itself is most valuable in data communications when the PBX is attached to the LAN and can be accessed by PC work stations for wide area communications. PBX-to-LAN connections are rare today but represent an important option for future applications in data communications at installations like the Army War College.

Another alternative is the use of the high quality Cable Television coaxial cable. Sometime in the not too distant future, Carlisle Barracks will have television cable installed to every quarters, building and office. The coaxial cable used for cable television services is high quality -- capable of handling high baud rates and high volume use. Many military installations already have contractual agreements with cable television firms for the leasing of channels for such things as closed circuit TV programming. Likewise, Carlisle Barracks could contract for the use of two or three channels for computer communications. One channel, for example, could be used for connecting student and faculty quarters to the USAWC LAN. A second could be used to connect the various computer assets (TRADOC IBM 4361, Strategic Wargame Facility, Military History Institute, Garrison computer facility, and the AFFRI) at Carlisle Barracks with the college LAN. As one can easily see the television coaxial cable offers a relatively inexpensive option for computer connectivity.

The disadvantages of this technique are same as those of the PBX system; except, it is more dependable, it provides some degree of security or privacy, and has the quality for moving large amounts of data accurately.

The above discussion serves only to illustrate the alternatives and their advantages and disadvantages. Probably the most significant disadvantage of the PBX and the television cable, or one that creates the most paranoia for military leaders, is the lack of security and/or privacy. The key advantage of both is that they are reasonably inexpensive ways to allow remote workstation access to the college LAN. Such LAN architecture is basically a peer-to-peer system. Compatible PC workstations can handle their own processing and communicate as equals (peers) on the LAN. While, on the other hand, users of machines with operating systems that must use a communications emulator will share this privilege with minor losses in PC power.

LAN design is not without established standards. Even though the standards in establishing and managing networks is relative new, DoD has adopted rules for design and management protocols. It is important for system design decision makers to understand the concepts and their implications.

Communications and Standards

Until the mid 1980's, most of the focus for standardization in LANs had been on hardware standards. Several LAN vendors were able to point to relatively large installed bases and claim that their hardware would become the industry standard. But no single LAN hardware system emerged as the clear-cut winner.

As the hardware standard was being sought, people began to notice the shortcomings of such a standard. A hardware standard, as defined by its proponents, means that everyone uses the same type of LAN cable, the same cable layout, and the same access method. If such a standard became a reality, everyone would use this generalized LAN hardware solution. The many other LAN hardware alternatives would disappear. What became obvious was that no single type of hardware is best for all situations.

If a small office or operation, for example, needs to network three or four PCs, a simple twisted-pair cable hardware system may be the best solution. Twisted-pair cable is good for low data transmission rates and is very inexpensive. In this situation, multi-channel coaxial cable or fiber optic systems would be a waste of money. On the other hand, an accounting and finance office needs high data rates, and must support many PCs, so twisted-pair cable would not be appropriate.

The solution to this standardization dilemma was found in the software arena. Through software standards, operating system software provides a standard interface between LAN hardware and LAN applications. The International Organization for Standardization introduced the Open System Interconnection (OSI) Model as the basic framework for LAN design.

In 1985, the National Research Council (NRC) issued a report which concluded that key OSI protocols were functionally equivalent to military standard for computer networking. Following this report from the NRC, the Office of the Secretary of Defense (OSD) issued a directive that the OSI protocols would be the objective standard for Department of Defense Data Networks. Then following the publication of the Government OSI Profile (GOSIP) in April 1987, OSD declared the OSI protocols as the standard and directed the development of a transition and interoperability plan with existing systems. The main reasons for this transition from existing protocols to those specified by the OSI model are reduced cost, increased interoperability, and increased application-level functionality. OSI products are being developed with much cooperation and interaction among vendors worldwide. It appears that the OSI standards will be used by our North Atlantic Treaty Organization (NATO) allies, among others. 7

The OSI Model

For the purposes of this study, it is important for the reader to understand the basics of the Open System Interconnection (OSI) Model. The model divides the communications process into a hierarchy of functional layers, which are interdependent. Each layer has a built-in interface to the adjacent layer. For example, Layer 2 can pass data to Layer 3 or Layer 1, but Layer 1 cannot communicate directly with Layer 3. The layers are as follows:

Layers 1 (physical) and 2 (data-link) are the hardware layers, providing the basic connectivity. The network layout and bandwidth (speed) are determined in these layers.

Layers 3, 4, and 5, (named the "network", "transport", and "session" layers respectively), combine to form the network's so-called "subnet" level, which contains the software that controls the network hardware. Briefly, the subnet level establishes and manages the temporary link between sender and receiver. This link is sometimes called a "virtual connection" to distinguish it from a physical connection.

Layer 6, "presentation" layer, is another application-to-network interface. Almost all software application programs should attach to the network through this layer.

Layer 7, "applications" layer, defines the many utility programs uses for network management.

The above illustrates the amount of software that must be written to facilitate each level and what confronts the Department of Defense (DoD) in transitioning from current military standard protocols to the OSI protocols. However, OSI products are being developed with much cooperation and interaction among vendors. Efforts are being made to ensure conformance to the OSI standards and to ensure interoperability between products of different vendors. For DoD services and agencies, this means that computer networking can be done by an integration of multi-vendor, commercial off-the-shelf components. This will be different from historical DoD networking for which commercial products have been widely unavailable. This easy access to vendor interoperable off-the-shelf products will give wider availability to networking capabilities at a much reduced cost.

The target levels of DoD interoperability at each OSI layer will be directed by OSD. However, the "experimental interoperability" was to be achieved by 1989. By January 1991, procurement of OSI protocols will be mandatory and DoD/OSI interoperability will be at an "advanced level." The OSI product forecast schedule is to have all the OSI layers available by mid 1991. The longest running protocols being those for security and management (layer 7). 8

This DoD/OSI development is an important consideration for the information management decision makers at the Army War College. Investment in system upgrades or expansion

through purchase of additional equipment and software might best wait until OSI protocols are complete. It is interesting that the current system at the college is an open system and transition to the new protocols should be easy and relatively inexpensive. The near term fielding of the DoD OSI protocols reinforces the idea of an interim inexpensive way to open the college's LAN for remote interconnection.

Remote Interconnection

Until now we have been considering the options for so-called hard-wired interconnections. The thrust of this paper, as stated earlier, is to consider not only the hard-wire needs of the Army War College but the need to connect remote PCs, LANs and possibly other communications systems and services into the local area network.

Often, a remote connection is achieved through the attachment of a modem to any PC work station that needs to communicate outside the LAN or into the LAN. By converting between a computer digital signal and telephone-type analog signal, modems allow computers to send and receive across standard telephone lines.

Two software options permit remote interconnection; these are commonly referred to as "remote login" and "screen transfer." With remote login, the person dials into the LAN through a PC acting as a "bridge." That is, the person logs in to the LAN as if his/her PC were physically attached to the network. The only limitation is that the response across the telephone line is very slow compared to the local response times on a LAN. Using a screen transfer technique, a remote PC is connected to a PC that is attached to a LAN. The remote PC takes control of the local PC, issuing keyboard commands and receiving the display output.

The choice between these two interconnection options is strictly a transactional issue. If the user can run the bulk of his/her application locally, and all he/she really

wants to do is perform some transactional access onto a file, logging into the network with a personal PC through a remote connection is a good way to accomplish that task. The remote login is not practical for moving large files and applications back and forth, because of the slow speed of the telephone line connection. If the user needs to load an application that is stored on the network and is not in his/her local PC, then the user is better off executing on the network by using a screen transfer program.

Remote execution is ideal when the application program is stored on the LAN. This method reduces the amount of traffic that must be sent across the slow telephone lines. Only commands and display screens must be passed between the remote PC and the network. Remote execution is also excellent for the instructor/advisor. An instructor/advisor can closely replicate the situation at the remote LAN and thereby respond to the questions of the user/student.

When planning to create a wide area network to include the resident and non-resident students, you must consider the amount of traffic that will be transmitted. The public network (AT&T, Tymnet, or Telenet, for example, are referred to as X.25 links) is the best option if the connection is solely for some low-volume administrative function. The student can access the LAN in one of two ways. The school can install a gateway that is public-network-interface

compatible, enabling the user to use the public network protocol. Or the student can use a modem to connect to the public network, with his/her system appearing as an asynchronous terminal.

An asynchronous modem and dial-up line are appropriate for very low traffic loads. To access the network, the user turns on his/her modem, loads the communications software, and dials the LAN number. This inexpensive method enables many remote users to access the LAN. This method even works with an electronic mail system, in which the mail is collected at some point in the LAN and remote users dial in to pick up and send mail.

With heavier traffic the modem and dial-up line method is slow and inefficient. The solution for large volume transmissions to and from the college is the Defense Data Network (DDN). Most remote military users, non-resident students and others, are either on or near an installation with DDN access. The higher-speed lines used by DDN send messages quickly and cost less per mile than voice grade lines. The choice and expense depends upon the length of the transmission. The cost of using a link on a public data network is inexpensive compared to paying the telephone bill communicating over voice grade lines.

Conclusions

The Personal Computer's (PC) influence in the workplace and the educational process has been and will continue to be dramatic. They have expanded into every profession and discipline, and information access and management have become the most important aspects of success or failure. Thanks to the new power of PCs and their Information Access and Management capabilities, military leaders are starting to work more like intellects and classic researchers, gathering and integrating information from multiple sources and assimilating it for presentation and persuasion. For the most part, these computer skills are self taught.

The use of PCs in education has changed dramatically. Educational software development and networking systems have flourished, and many schools have made significant progress in the application and use of PCs in education. They only differ from the USAWC in size and academic focus, but all share a commitment to the idea that putting powerful tools in the hands of students and faculty can make a big difference in the quality of education. The USAWC has done a great deal in providing computer tools for students, faculty and staffs; however, several issues need to be dealt with before the true power of PCs can be achieved:

- Technological advances have moved faster than the college has adjusted to integrating PCs into the curriculum.

- The programming staff is not oriented to working with the faculty in developing "courseware."

- The computer-based instruction is inadequate.
- The INTELL computer system is ill-suited for the processing needs of the college.
- The LAN needs to be opened for remote access by students, resident and non-resident, and faculty.

Solutions to these issues are not easy, and the recommendations made in this study are not ideal. The purpose in this study project is to stimulate thought in redesigning the USAWC's ADP system for educational computing. Congressional restrictions on ADP funding will not allow for drastic changes, such as the complete overhaul of the system. But certain relatively inexpensive changes can be made that would move the college a step closer to the "new educational computing model" presented in this paper.

Four changes have been recommended: First, modem and dial-in/out capability should be made available to the students. The hardware and software is presently available. Next, an operating system emulator and communications package like Century Software's TERM package would allow student and faculty with IBM, IBM compatibles, Macintosh, and other systems the ability to access the LAN and interface with the college's systems. Third, the USAWC Library CATs system should be connected to the LAN. This would facilitate remote access via LAN terminal/PC or modem. Finally, a proper mix of machines and software is needed to meet the needs of the students, staff and faculty. Simply put, UNIX, XENIX, and DOS machines are excellent number

crunchers. The Q-ONE wordprocessor is much less than satisfactory. There is a much better wordprocessor for the INTELL system. Even though most students stated that they preferred the WORD PERFECT wordprocessor, there is not a version for the INTELL system. However, LYRIX is a reasonable substitute that works on the INTELL processor. For graphics and drawing (and wordprocessing) there is no better system than the Macintosh system. A Macintosh should be placed in each seminar room and several in the computer cluster room for student use. Eventually, if and when funding permits, the entire system needs to be overhauled. The slow INTELL 310/320, 8MHZ processors and software need to be replaced with at least 20 to 25MHZ processors and software that will meet the information processing demands.

A redesign of the system architecture will align it more with the roles of instructors and students in the seminar learning environment. The ease of information access and manipulation afforded by computers allows instructors to act as curriculum strategist and classroom coaches -- guiding students easily toward discovering answers on their own with computers. This overhaul will require turning the curriculum on its ear -- but the result will surely be an officer who is prepared to meet the demands of the information age.

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